Unmanned Systems
Network-Centric Operations

Chinh Nguyen, Raj Samuel, Hoa Nguyen, Daniel Carroll
SPAWAR Systems Center San Diego

Nhu-Nga Do
Command and Control Program Management Office, PMW 150
Program Executive Office, C4I & Space

Outline

> Network Centric

> SSC San Diego UV Initiatives

> Network ISR (NISR)

> Way Ahead

SPAWAR
Systems Center
San Diego

1. REPORT DATE **2005**	2. REPORT TYPE **N/A**	3. DATES COVERED **-**	
4. TITLE AND SUBTITLE **Unmanned Systems Network-Centric Operations**		5a. CONTRACT NUMBER	
		5b. GRANT NUMBER	
		5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)		5d. PROJECT NUMBER	
		5e. TASK NUMBER	
		5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **SPAWAR Systems Center 53560 Hull Street San Diego, CA 92152**		8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)	
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release, distribution unlimited**			
13. SUPPLEMENTARY NOTES **The original document contains color images.**			
14. ABSTRACT			
15. SUBJECT TERMS			

| 16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT **SAR**	18. NUMBER OF PAGES **20**	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**			

Network Centric

> C3 Transformation

> Notional Operational View

> FORCEnet Services Infrastructure (FSI)

> Composeable FORCEnet (CFn)

> Enabling Technologies

SSC San Diego's Joint Vision

**To be the nation's
pre-eminent provider
of integrated C4ISR solutions
for warrior information dominance**

C3I Transformation

Network Centric Operations

Networked Information

- Manual Stovepipe Operations
- Non coherent architectures
- Limited Operational Capabilities
- Islands of C2 capability

- Fully Integrated & Automated C3I
- Flexibility & Adaptability
- Interoperability
- Information Operations

Legacy

Objective

25 Oct 2005

5

Conceptual Operational View

IBGWN   FSI   Platform

UAV

USV   MANET

UUV
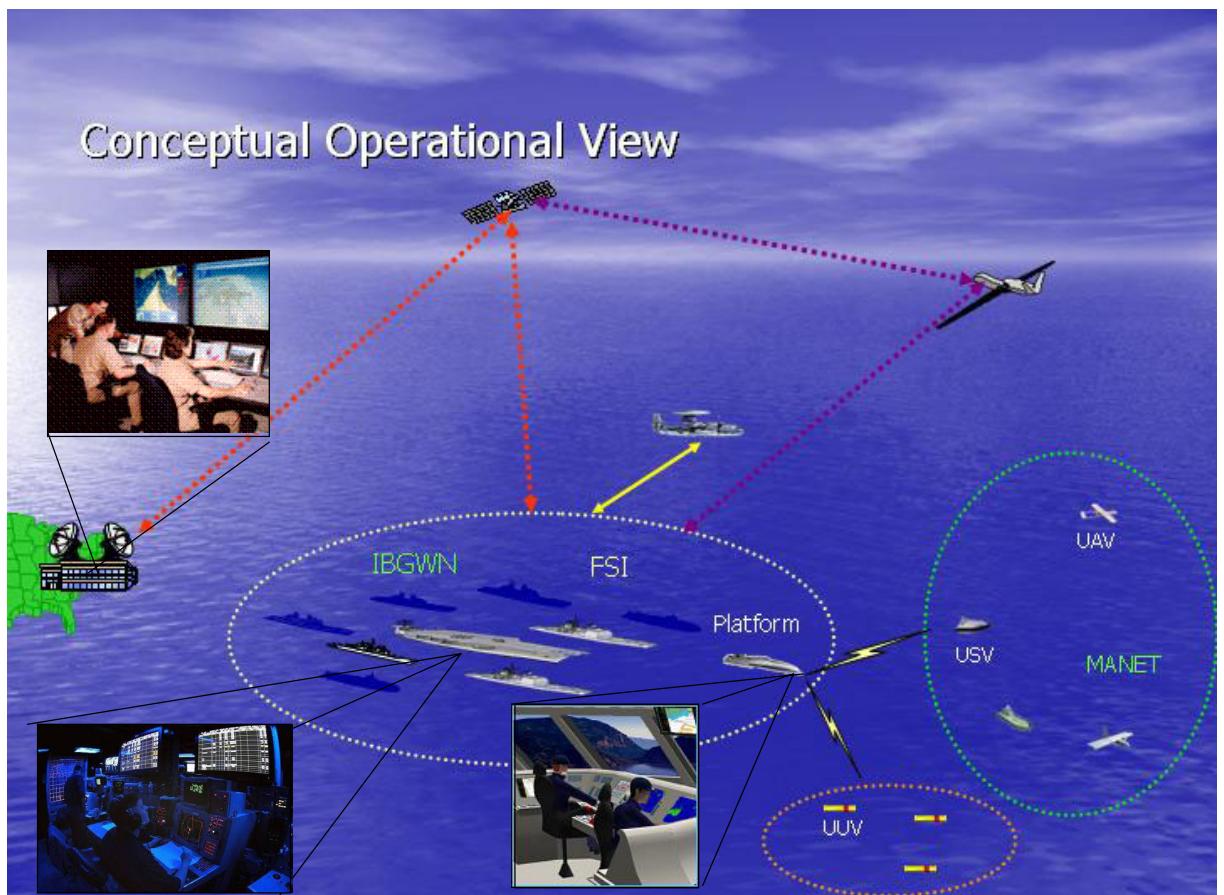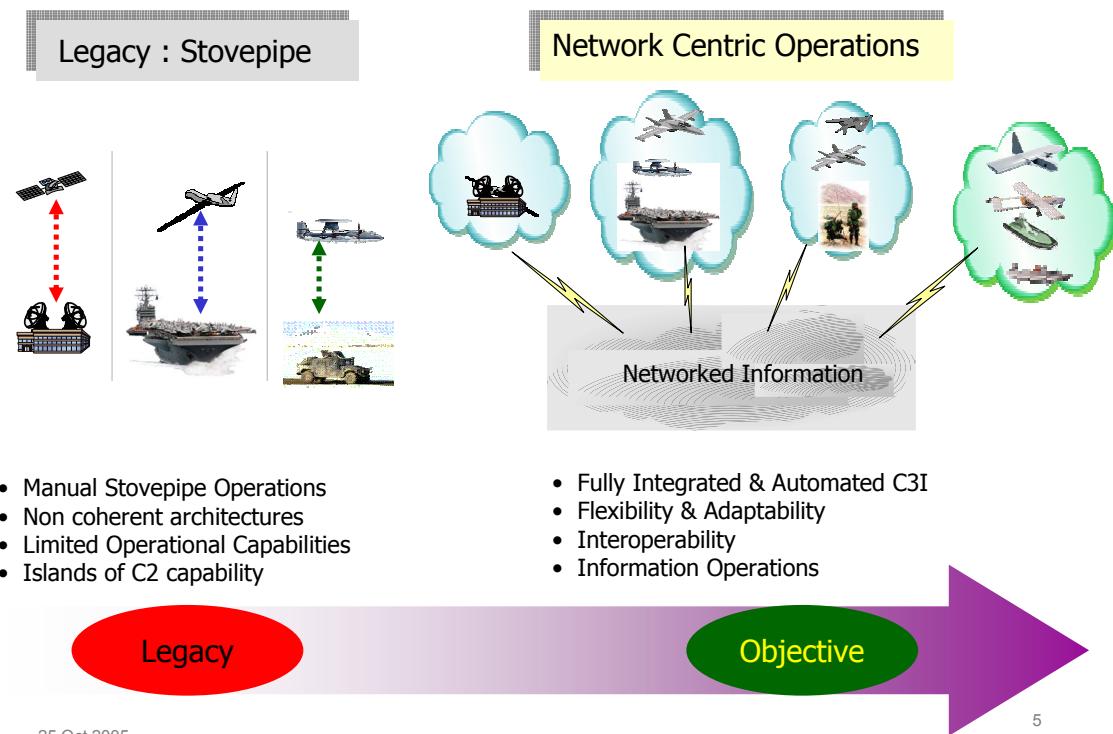
FORCEnet Services Infrastructure (FSI)

- **FORCENet**
 - Network Centric Warfare is the Theory
  - Net-centric operations is the Concept
  - FORCENet is the process of making the Theory & Concept a reality.
  - FORCEnet is the foundation for Sea Power 21
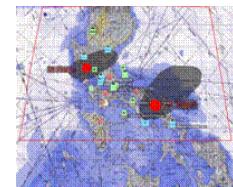
- **FSI**
  - FSI is FORCENet's mechanism for delivering Service Oriented Architecture environment
  - An open architecture, …… web-based C2 and information management system
    - Provides ability to "fuse" data from multiple otherwise non-interoperable systems on a single display
  - Installed in CTF72, CTF74, LCC19 (USS Blue Ridge)
  - Planned installation in CVN76 (USS Ronald Reagan)
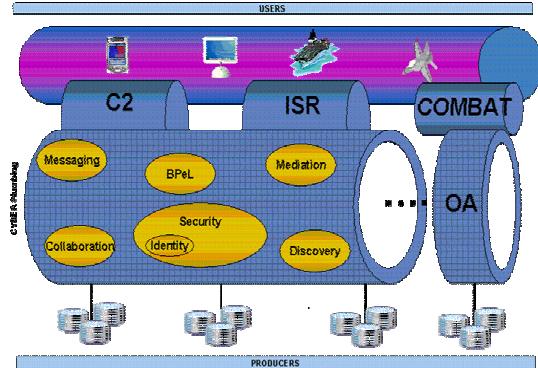
"Transforming Information Into Decisive Effects"

Composeable FORCEnet
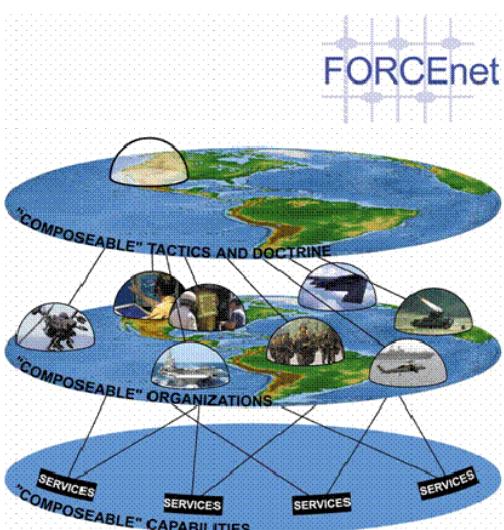
Transform *Operations*

- Assemble components on the fly

- Interoperable – Agile – Tailorable

- Geospatial – based shared awareness & collaboration

- Intuitive linkage to information

Sample CFn View
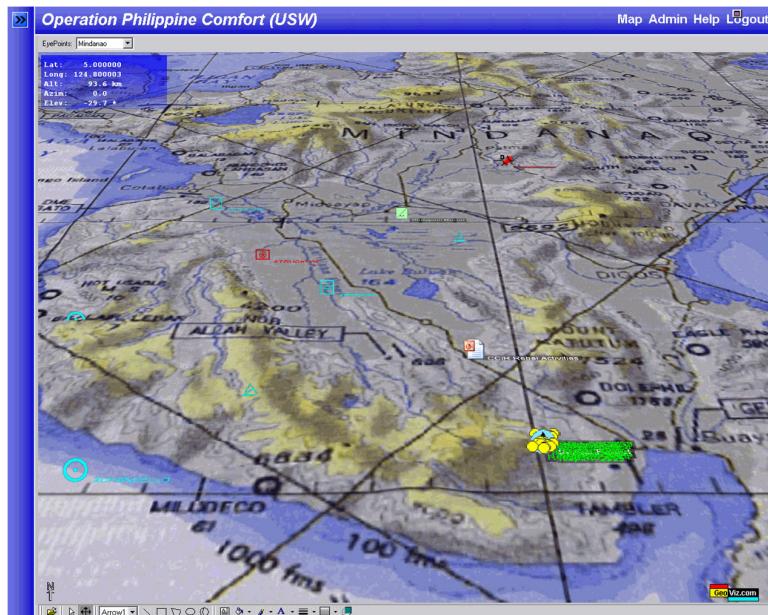
Enabling Technologies

> Unmanned Vehicles

> Sensors / Payloads

> UV C2

> Secure Wireless Network

> Data Management & Fusion

Y2K UUVMP and UUV Programs

UUV Master Plan 2000 guided UUV developments in 4 signature capability areas

Maritime Reconnaissance

| Intel Collection | → | Target Designation | → | UAV Launcher | → | Missile Launcher |

- **AOFNC** Maritime Reconnaissance
- **Mission Reconfigurable UUV MRUUV 21" Diameter**
- **Mission Reconfigurable UUV Large Displacement**

Undersea Search and Survey

| Area Reconnaissance | → | Area Clearance | → | Autonomous Work |

Area Clearance

- **Seahorse**
- **SAMS** Subsurface Autonomous Mapping System
- **SAHRV** Semi Autonomous Hydrographic Reconnaissance Vehicle
- **SCM** Search, Classify, Map
- **BPAUV** Battlespace Prep AUV
- **AMNS** Airborne Mine Neutralization System

- **AN/BLQ-11**
- **AN/BLQ-11 P³I**
- **MRUUV LD**
- **AOFNC** Undersea Search and Survey
- **RI / N / EOD** Reacquire, Identify, Neutralize, EOD UUV

Communications / Navigation Aid

| Nav Relay Comm Relay | → | Mobile Undersea Network | → | GPS Augmentation |

- **AOFNC** Communication/ Navigation Aid

Submarine Track and Trail

| Sub Hunter | → | UUV Hunter | → | Undersea Weapons |

- **MRUUV LD**

UUV Master Plan Program Roadmap

Activity	FY00	FY04	FY08	FY12	FY16+
Special Purpose	e.g. Full Ocean Depth	SAMS			
Man Portable	SAHRV, SCM	NSW / EOD Man Portable Systems, Potentially Other			
		VSW Recon	Insp. ID, CN3	Neut. UUV	NSW ISR
Light Weight		LWV Class, Surface / USV Launch, Potentially Other			
			MCM, CN3	IO	
Heavy Weight	LMRS MRUUV	HWV Class, Surface / SSN Use			
		MCM (interim)	Tac ISR	MCM IPB, DECOY	
Large			Large Class, Surface, Submarine		
			LR Oceanography	PLD (ASW), ISR	STT, TCS
Technology	AOFNC (MRD, USS, CNA, STT), MCM FNC, D&I, DARPA US/UK PA MCM - ISR/ASW, SBIR, IRAD, LABS, NRL				

SSC - San Diego

C4ISR UV Interoperability Imperatives

> Unmanned Systems Command and Control (C2)
> Unmanned Ground Vehicle (UGV) C2 Interoperability
> Unmanned Surface Vehicle (USV) C2
> Autonomous UAV Mission System
> UGV Remote Operations

25 Oct 2005

Unmanned Systems Command and Control (C2)

Fielded in WTC & OEF Afghanistan

FY05 Fielding for SPARTAN ACTD

SMART → **IDD/Video Plug-n-Fight** → **MOCU**

IDD Video

Plug-n-Fight

Multi-UV Control

Scalability

GUI

MRHA

Protocol Rules

Interoperability

Common Controller

FY04 Fielding for MDARS EUA

JAUS

FY05 Fielding for Night Vision Cave & Urban Assault ACTD

FORCEnet, Future Combat Systems (FCS), REDCAR, JUSC2, MTRS
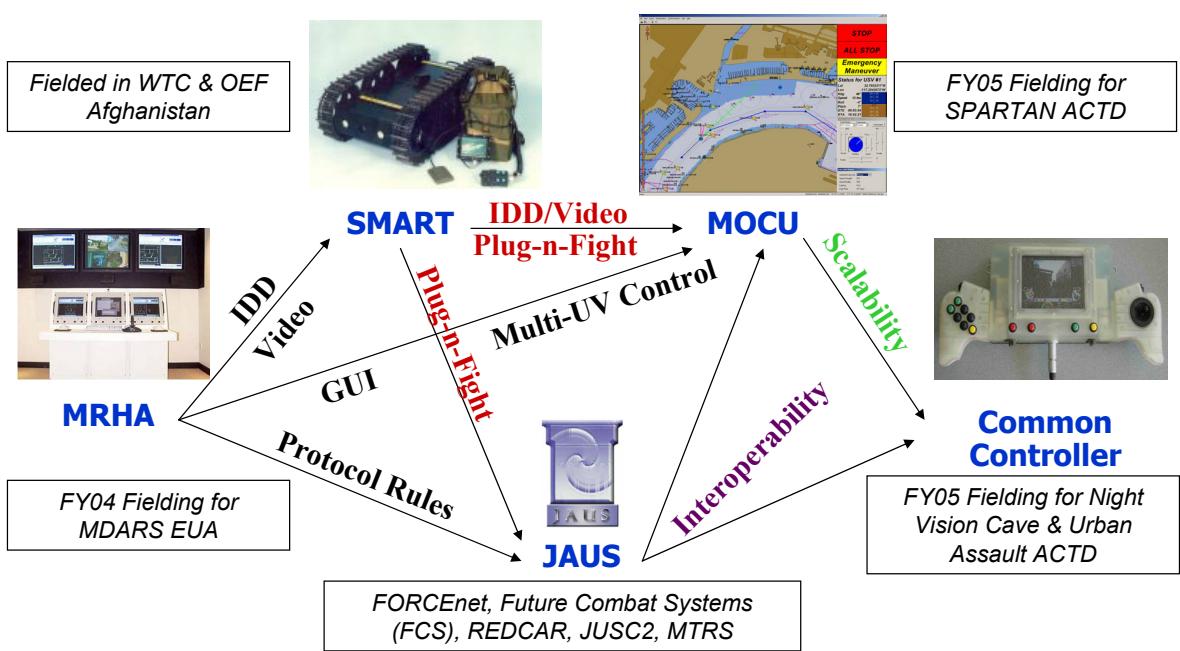
25 Oct 2005

Unmanned Ground Vehicle C2 Interoperability

Matilda

Common Controller

URBOT

Andros

Eel

Packbot

TAGS

SSC San Diego
NSWC-PC (Navy)
AMRDEC (Army)
AFRL (Air Force)
AAC/WMO (Air Force)
Remotec/Apple Aid
Autonomous Solutions
iRobot

Joint Architecture for Unmanned Systems (JAUS)
- JAUS is standards-based approach defining common message sets
- Operator Control Unit (OCU) Experiment - Dec 2003 (SSC San Diego)
  - 9 organizations – 5 DoD and 4 industry
  - 6 Unmanned Ground Vehicle (UGV) systems
    - Each UGV dynamically registers with every OCU
    - Each OCU displays status of all UGVs on network
    - Each OCU is able to take control and drive any UGV

25 Oct 2005

Unmanned Surface Vehicle C2

Operational Relevance
- C2 system for the Spartan ACTD
- Provides C2 of multiple heterogeneous unmanned systems
- Controls and monitors up to 4 Spartan USVs simultaneously with 1 operator

Technology Development
- Provides tele-operation and mission planning for each USV
- Expands on the Multi-robot Operator Control Unit
- Displays up to 30 radar contacts for each vehicle
- Displays raw radar image for selected vehicle
- Allows user to define operation areas as well as exclusion areas
- Interfaces to the Spartan Modular payloads

25 Oct 2005

Autonomous UAV Mission System (AUMS)

Operational Relevance

- Develop an automated system for a UAV to be launched, captured, refueled, and re-launched
- Can operate from USVs, UGVs, HMMWVs, and fixed stations
  - Decreases time and personnel required to refuel UAV
  - Increases the number of missions the UAV can complete
- Applicable to MDARS, REDCAR, FCS, PerceptOR, and SPARTAN programs

Accomplishments

- Developed and tested several fixtures for launch and recovery of iSTAR UAV from MDARS UGV
- Established UAV test facility
- Developed automated refueling system for iSTAR mockup
- Working with USC on precision landing

25 Oct 2005

17

UGV Remote Operations

MDARS: Mobile Detection, Assessment, Response System

MDARS Early User Assessment (EUA)

FY05 - One-year EUA at Hawthorne Army Depot, NV, 4 MDARS patrol units operating during evenings and weekends covering over 72 miles of roadways across largest depot in US
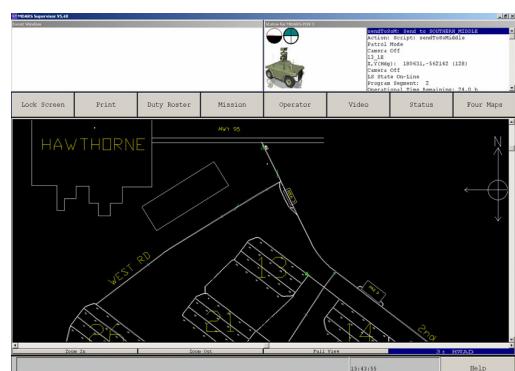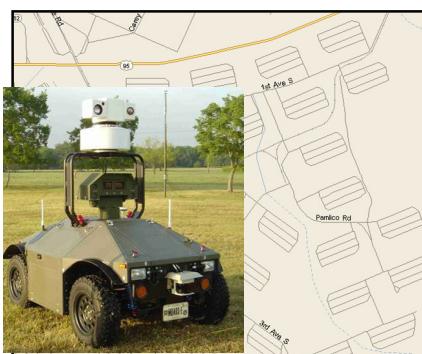
Navy Reserve Reachback MDARS Experiment

FY05 – Navy Reserve experiment for networked unmanned vehicles
Virtual Operation at SD Joint Reservist Intelligence Center (JRIC)
Controlling MDARS patrol units at Hawthorne Army Depot over 470 miles away via T1 and Virtual Private Network (VPN)

25 Oct 2005

18

Networked ISR (NISR)

> Objective

> Requirements

> Development

NISR Objectives

- Integration of Unmanned Vehicle Systems into Composeable FORCEnet (CFn)

- Demonstrate from a remote site such as the SSC – San Diego Command Center of the Future (CCOF)
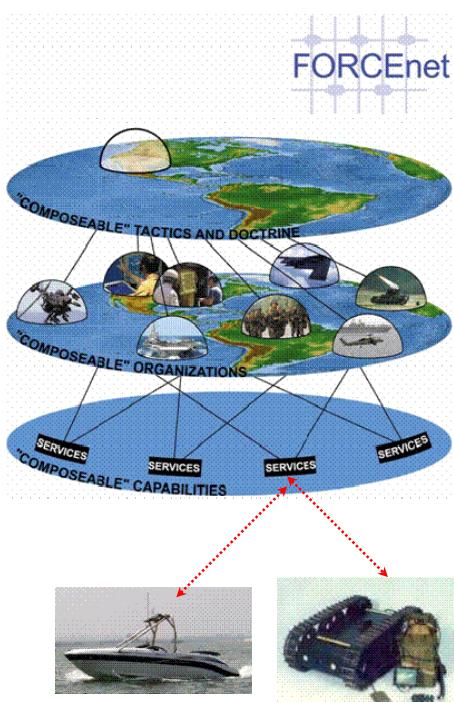
Requirements

- Operational approach
  - Hands-off monitoring – FCn is not the main controller
  - Data rate in the order of seconds
  - Net-centric web based interface

- Core requirements
  - Provide robotic data and functions common to most unmanned systems
    - Robot position
    - Local map imagery
    - Video feed
    - Way point

Spiral Development

- Phase I – develop baseline capabilities for web-based robotic controls

- Phase II – integrate Phase I solution to Composeable FORCEnet, develop demo scenarios

Phase I Development

- Development challenges
  - Network latency
  - Web interface to robotic resources
  - Wireless network security

- Design decisions
 - Java development
  - Client/Server model
  - SecNet 11

Composeable FORCEnet (CFn)

Phase I Block Diagram

Visualization

Normalization tier

Data/Info sources

Robot Server

Web Interface Client
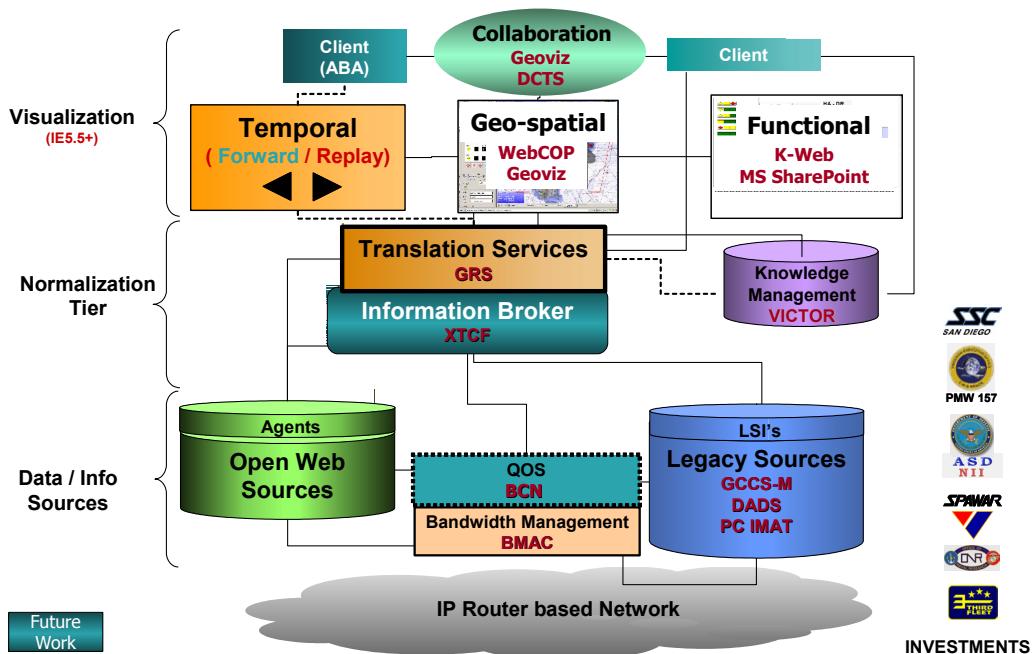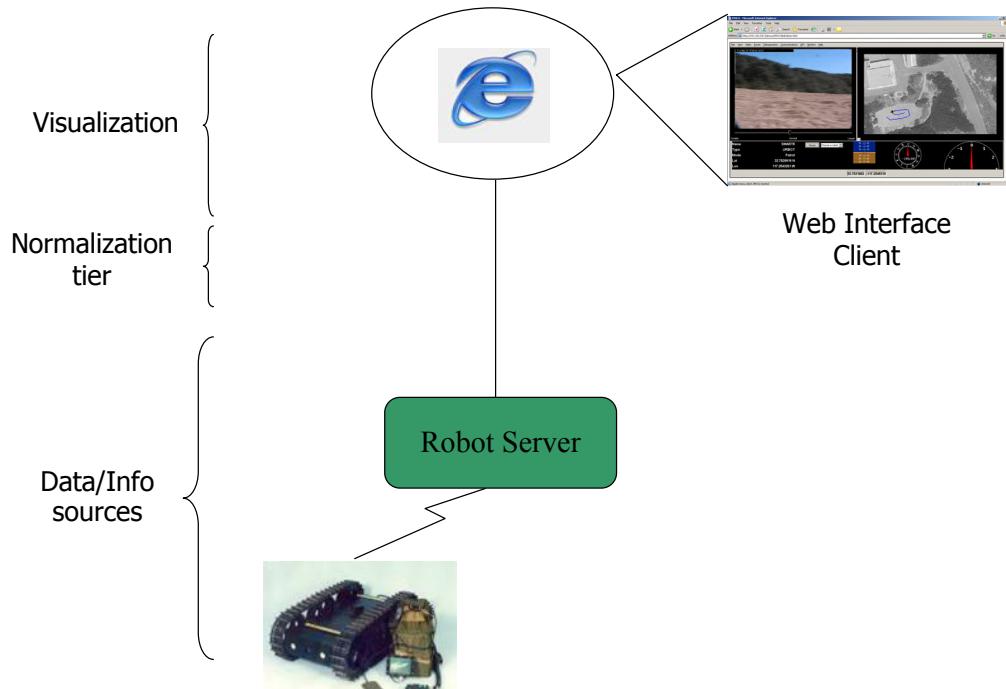
NISR Phase I Network Layout

SecNet 11®
Secure Wireless Local Area Network

SecNet 11®
Secure Wireless Local Area Network

SecNet 11®
Secure Wireless Local Area Network
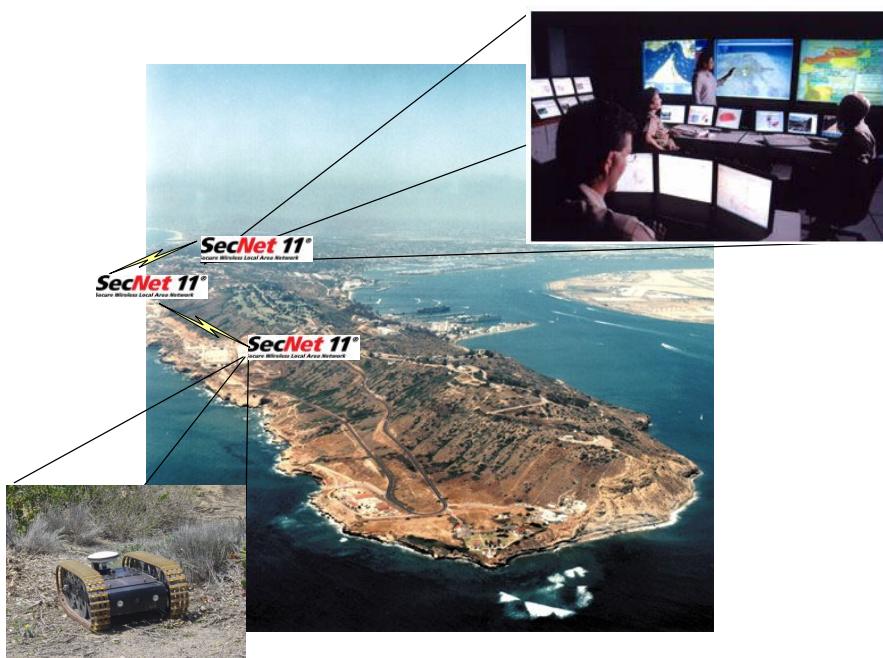
Web Controller

NISR Phase II

- Integrate Phase I with CFn
  - Publish robotic information to Geospatial Replication Service (GRS)/ Geospatial Collaboration Service (GCS)
  - Integrate USV
  - Integrate static sensors (fixed video cameras)

- Obtain network Certification and Accreditation

Phase II Development

- Development challenges
  - Defining XML interface to GRS
  - System integration
  - Certification and Accreditation (CA) of wireless network
  - Develop demonstration scenarios
- Design decisions
  - OpenGIS standard for geospatial XML definition
  - Java Messaging Service (JMS)

# Phase II Block Diagram

Visualization
(IE 5.5+)

Normalization
Tier

Data / Info
Sources

Collaboration
Geoviz
DCTS

Geo-spatial
WebCOP
Geoviz

Translation Services
GRS

Robot Server
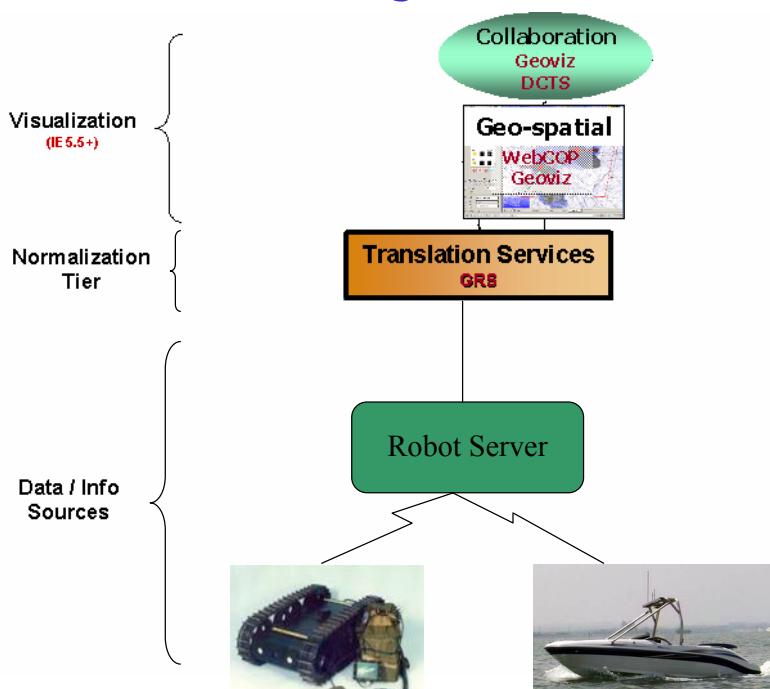
Phase II Network Layout

802.11b

ROUTER

S&T
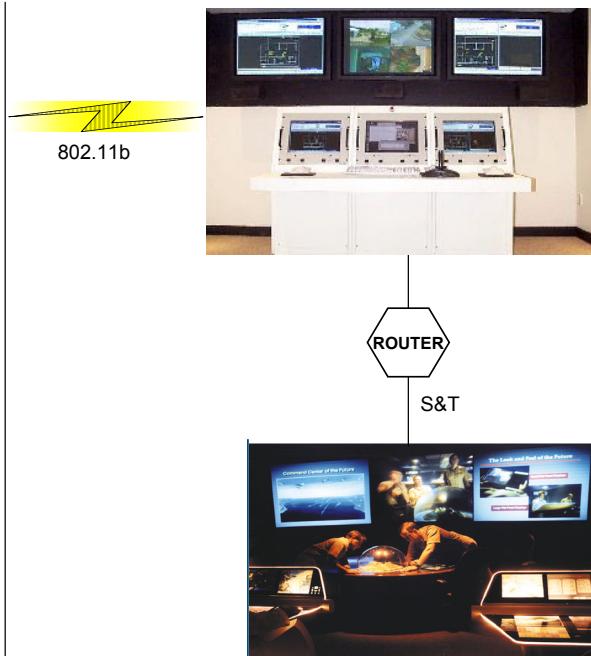
NISR Operation – Direct Control
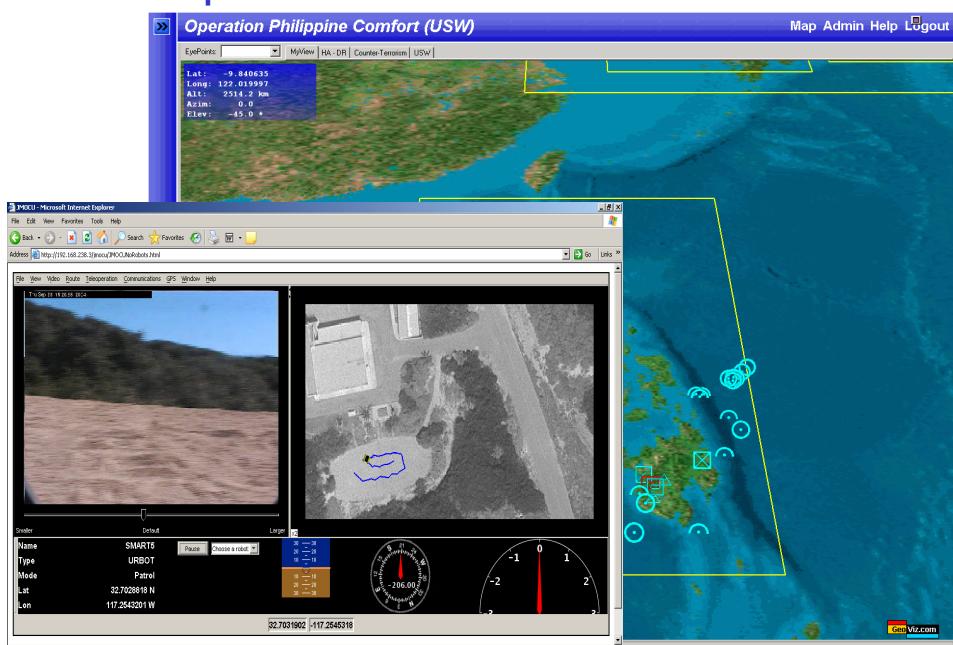
NISR Scenario - Collaboration
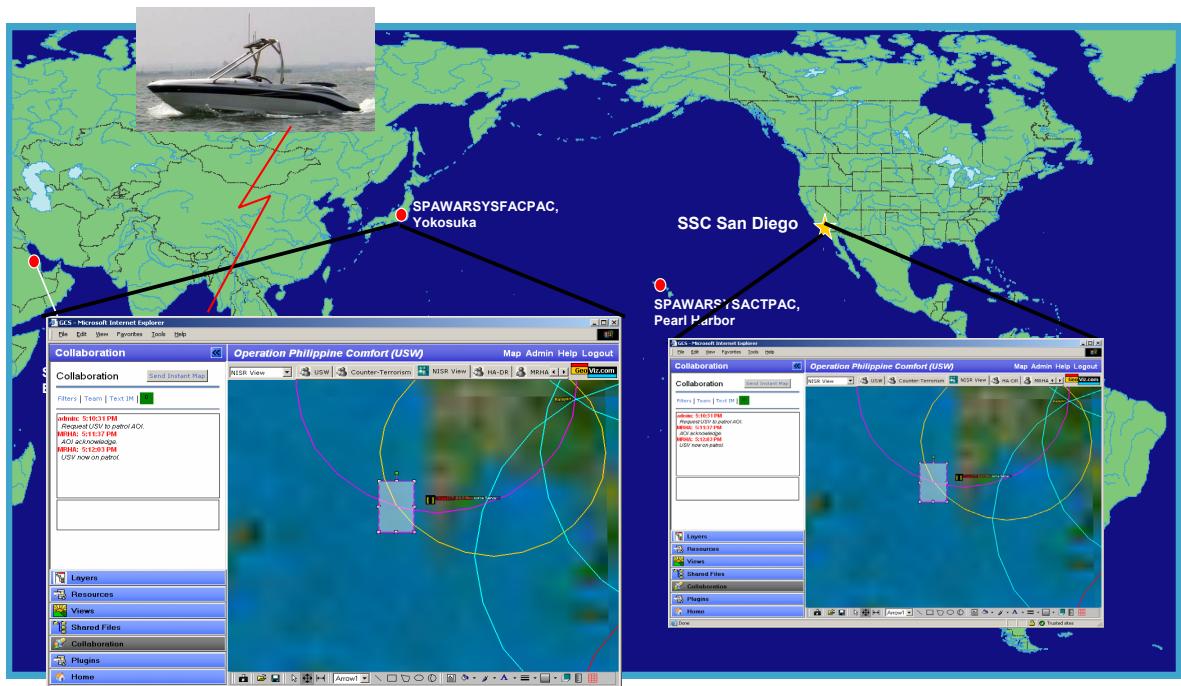
Collaboration Scenario

NISR Spiral Development

INTEGRATED NETWORK MANAGER

Common OCU — ROUTER — Radios — STANAG, STANAG, JAUS, JAUS

FSI — Network Distributed Control — ROUTER — Radios

```
FSI:            FORCENet Services Infrastructure
JAUS:           Joint Architecture for Unmanned Systems
OCU:            Operator Control Unit
STANAG 4586:    Standard for NATO UAV interoperability
```

ONBT

SPAWAR
Systems Center
San Diego
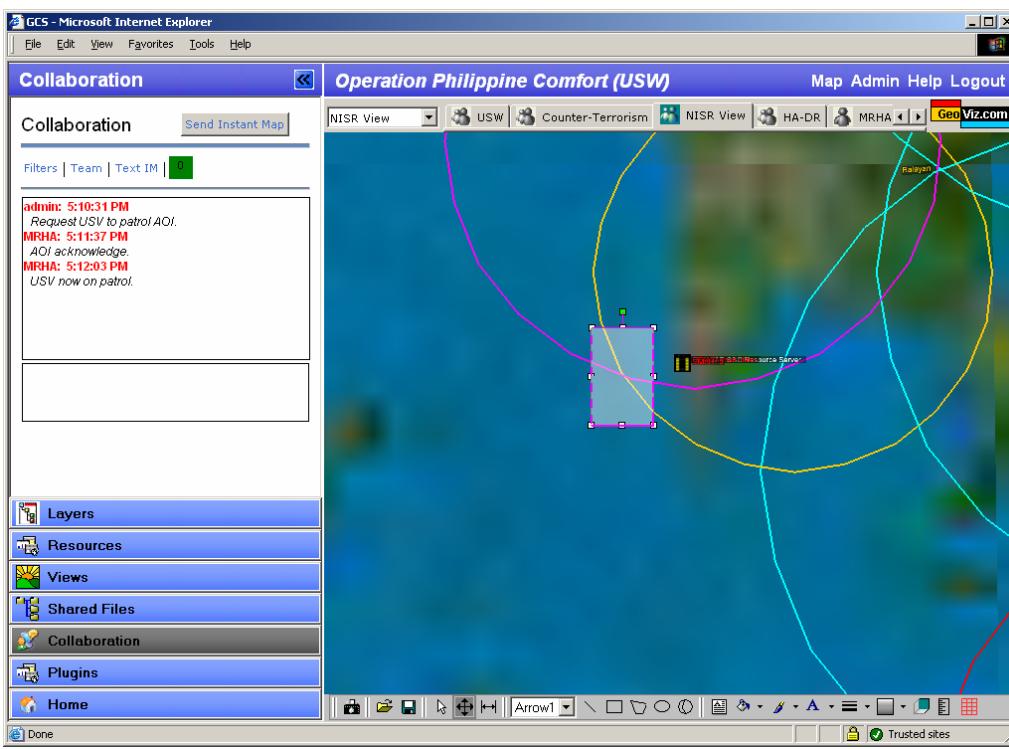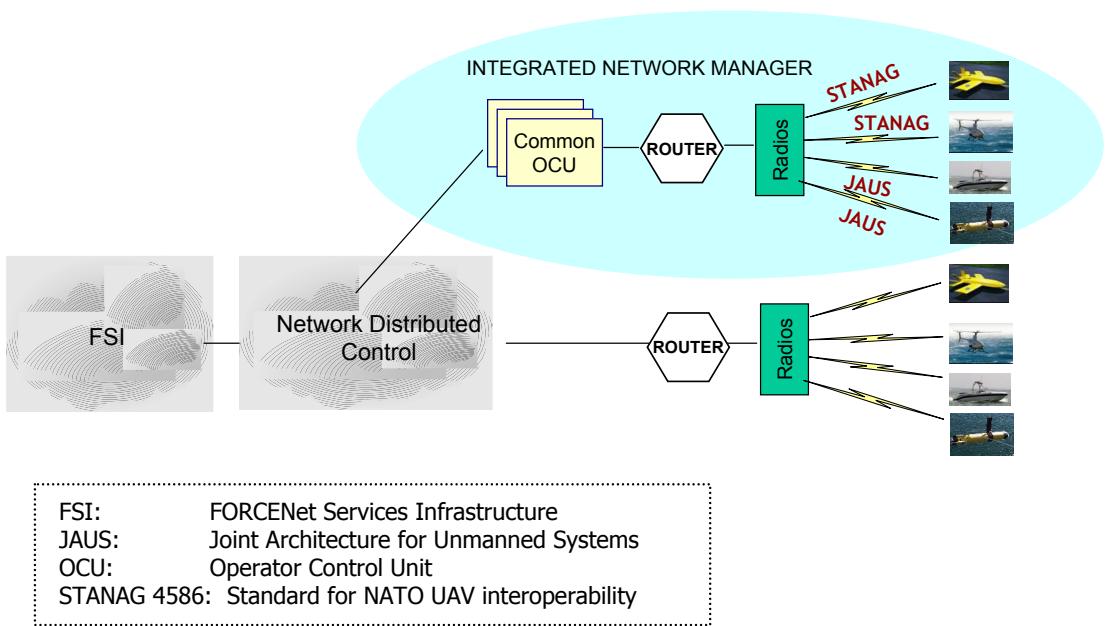
Partners

- NAVSEA
  - Carderock
  - Newport
  - Panama City
  - Philadelphia
- Naval Post Graduate School
- MCTSSA – Pendleton
- CERDEC* - Ft. Monmouth
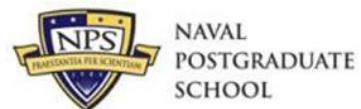
* Communications-Electronics Research, Development and Engineering Center

---

Way Ahead

Autonomous UV systems
Collaborative cross-cue UV systems
Secure wireless network
Netcentric Architecture
    Open architecture
    Re-usable & Scaleable
GIG compliant ... *Power to the Edge*
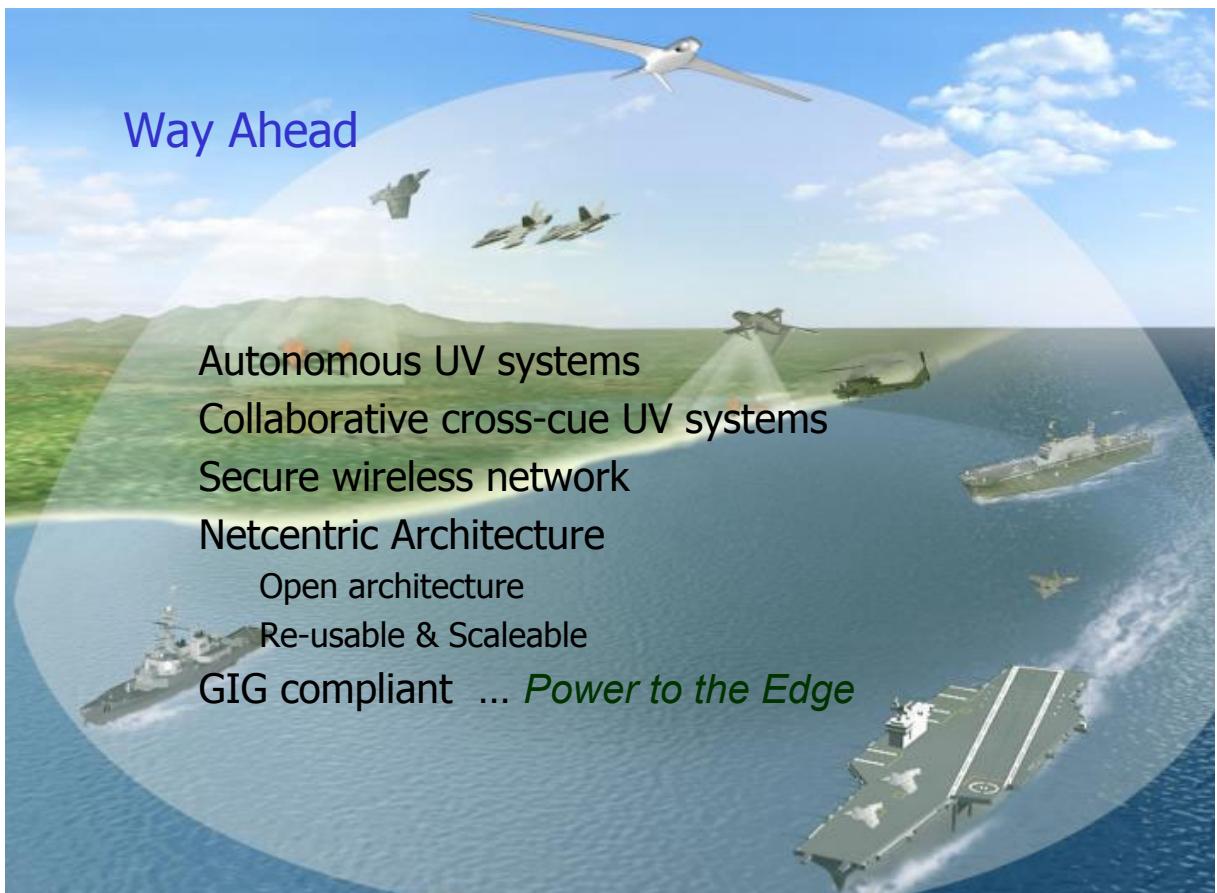
Contact Information

- **Chinh Nguyen**, Lead Engineer
  Networked ISR, Code 2371, SSC San Diego
  chinh.nguyen@navy.mil, 619-553-5966

- **Raj Samuel,** Project Manager
  Networked ISR, Code 2846, SSC San Diego
  raj.samuel@navy.mil, 619-767-4156

- **Hoa Nguyen**, Branch Head
  Unmanned Systems, Code 2371, SSC San Diego
  53406 Woodward Road, San Diego, CA 92152-7383
  hoa.nguyen@navy.mil, 619-553-1871

- **Daniel Carroll**, Project Manager
  Unmanned Vehicle Architecture, Code 2371, SSC San Diego
  daniel.carroll@navy.mil, 813-281-0560 x171

- **Nhu-Nga Do**, Assistant Program Manager
  Operational Command & Control, PMW 150, PEO C4I & Space
  nhu-nga.do@navy.mil; 858-537-0398

http://www.spawar.navy.mil/robots/

25 Oct 2005